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Objective—To determine signalment, history, and clinical, necropsy, and microbiologic findings in dairy cows with hemorrhagic bowel syndrome.

Design—Retrospective study.

Animals—22 adult dairy cows from a single farm in Colorado.

Procedure—Medical records were reviewed for information on signalment, medical and reproductive history, the owner’s chief complaints, results of physical examinations and ancillary diagnostic tests, treatment and response to treatment, results of microbiologic testing, and, if applicable, postmortem findings.

Results—Common clinical signs were acute signs of profound depression, decreased milk production, tachycardia, ruminal stasis, abdominal distention, and dark clotted blood in the feces. Rectal examination revealed distended loops of small intestine in 7 of 14 cows. Transabdominal ultrasonography revealed small intestinal ileus and distention in 12 of 12 cows and homogeneous echogenic intraluminal material compatible with intraluminal hemorrhage and clot formation in 4. Seven of 8 cows treated medically died; 9 of 13 cows that underwent surgery died or were euthanatized. Clostridium perfringens was isolated from fecal samples from 17 of 20 cows. The most common morphologic diagnosis at necropsy was severe necrohemorrhagic enteritis or jejunitis with intraluminal hemorrhage or blood clots. The most prominent histologic finding was severe, segmental submucosal hemorrhage and edema of the small intestine.

Conclusions and Clinical Relevance—Results confirmed that in adult cattle, hemorrhagic bowel syndrome is a sporadic acute intestinal disorder characterized by intraluminal hemorrhage and obstruction of the small intestine. Clostridium perfringens was consistently isolated from the feces of affected cows. The prognosis for affected cows was grave. (J Am Vet Med Assoc 2002;221:686–689)

Common causes of intraluminal enteric hemorrhage in adult cattle include intussusception, volvulus, salmonellosis, bovine viral diarrhea virus infection, coccidiosis, coagulopathies, and intestinal foreign bodies. Hemorrhagic bowel syndrome (HBS) is a sporadic disorder of adult cattle characterized by acute necrohemorrhagic enteritis that primarily affects the small intestine. This disorder is distinguished from other causes of intraluminal enteric hemorrhage by the tendency for affected animals to develop large intraluminal blood clots that result in obstruction of single or multiple segments of small intestine. Hemorrhagic bowel syndrome has also been called fatal jejunal hemorrhage syndrome and intraluminal-intramural hemorrhage of the small intestine. Recent reports suggest that the frequency of this disorder may be increasing in the United States. However, little is known about the cause or typical historical, physical examination, and clinicopathologic findings. In addition, no consistent predisposing factors have been identified. The purpose of the study reported here, therefore, was to determine signalment and history of and clinical, necropsy, and microbiologic findings in dairy cows with HBS.

Criteria for Selection of Cases

Medical records of all dairy cows examined at the Colorado State University Veterinary Teaching Hospital between 1997 and 2000 because of dysentery, melena, or colic were reviewed. Records of cows with hemorrhagic enteritis were selected for additional review. Cows were considered to have HBS if they had hemorrhagic enteritis, as evidenced by melena and clotted blood in the feces or small intestine, and did not have any evidence of an intestinal or extraintestinal lesion that might cause primary obstructive disease of the small or large intestine (e.g., intra-abdominal lesions, intussusception, or volvulus). Clotted blood in the small intestine was identified during transabdominal ultrasonography, an exploratory laparotomy, or necropsy.

Information regarding signalment, medical and reproductive history, and the owner’s chief complaints was obtained from the medical records, along with results of physical examinations and ancillary diagnostic tests, treatment and response to treatment, results of microbiologic testing, and, if applicable, postmortem findings.

Results

Twenty-two adult lactating Holstein dairy cows from a single herd in Colorado met the criteria for inclusion in the study. Cows ranged from 2 to 8 years old (mean, 4 years; median, 4 years). Time since parturition ranged from 9 to 319 days (mean, 107.5 days; median, 100 days). Milk production records were available for 14 cows; daily milk production for these cows ranged from 72 to 158 lb of milk/d (mean, 89.9 lb/d; median, 89.5 lb/d). Data on percentage milk fat were available for 14 cows; milk fat percentage in these cows ranged from 72 to 158 lb of milk/d (mean, 4 years; median, 4 years).

Eighteen of the cows were examined during 2000,
Sodium concentration was 130 mEq/L (reference range, 136 to 147 mEq/L). Sixteen cows had hypokalemia; median serum potassium concentration was 3.4 mEq/L (reference range, 3.4 to 5 mEq/L). All 19 cows had hypochloremia; median serum chloride concentration was 82 mEq/L (reference range, 95 to 105 mEq/L). Additional abnormalities included high serum bicarbonate concentration (n = 13), high anion gap (11), azotemia (5), hypocalcemia (6), hypercalcemia (2), hyperphosphatemia (5), and hypophosphatemia (1).

Serum enzyme activities were high in several cows. Serum creatine kinase activity was high in 15 of 19 cows; median creatine kinase activity in these cows was 9,986 U/L (reference range, 57 to 280 U/L). Aspartate aminotransferase activity was high in 14 of 19 cows; median activity in these cows was 176 U/L (reference range, 40 to 130 U/L). γ-Glutamyltransferase activity was high in 13 of 19 cows; median activity in these cows was 49 U/L (reference range, 10 to 26 U/L). Sorbitol dehydrogenase activity was high in 13 of 19 cows; median activity in these cows was 58 U/L (reference range, 8 to 23 U/L).

Transabdominal ultrasonography was performed in 12 of the 22 cows. The small intestine could be imaged via the ventral aspect of the right paralumbar fossa in all 12, and dilated loops of intestine were evident in all 12 cows. In 4 cows, homogeneous echogenic material consistent with clotted blood was evident in the lumen of distended segments of intestine (Fig 1). Hypoechoic material consistent with fluid instega was observed in 3 cows.

Medical treatment varied. Sixteen cows were given flunixin meglumine IV shortly after admission. Thirteen cows were given fluids IV, and 7 were given fluids with electrolytes PO. Calcium salts were administered IV to 12 cows. Procaine penicillin G (22,000 U/kg [10,000 U/lb], IM) was given to 14 cows, and cefiotur sodium (2.2 mg/kg [1 mg/lb], IM or IV) was given to 6. Additional treatments included Clostridium perfringens types C and D antitoxin (5 cows), nalbuphine (6), metoclopramide (5), 3% lidocaine IV (4), erythromycin (3), and oxytetracycline (3). Ancillary medical treatments included dexamethasone (2 cows), neostigmine (2), morphine (2), magnesium hydroxide...
Salmonella

Results for all of these tests were negative, except that polymerase chain reaction assay for bluetongue virus.

and fecal samples from 2 cows were submitted for a polymerase chain testing for bovine viral diarrhea virus, fecal samples from 6 cows were submitted for fluorescent antibody testing for Salmonella, and aerobic bacterial culture for salmonellae, fecal samples from 4 cows were submitted for anaerobic bacterial culture, and all 5 yielded moderate to heavy growth. In addition, 5 of the 10 tissue samples of affected jejunum were submitted for aerobic bacterial culture, yielding moderate to heavy growth. In addition, 5 of the 10 tissue samples of affected jejunum were submitted for aerobic bacterial culture, and all 5 yielded C perfringens.

Biopsy specimens of the small intestine were collected from 10 of the 13 cows that underwent surgery. The most prominent histologic finding was severe, segmental submucosal hemorrhage and edema of the proximal portion of the small intestine, primarily the jejunum (9), distended loops of bowel (6), dark red to purple discoloration of the serosal surface of the bowel (3), and intraluminal blood clots tightly adherent to the mucosa (2). Other surgical findings included frank blood in the lumen of the intestine, sloughed intestinal mucosa, and fibrinuous adhesions (1 cow each).

Fecal samples from 20 of the 22 cows were submitted for anaerobic bacterial culture. Clostridium perfringens was isolated from 17 of the 20 (85%), with 14 of the 17 yielding moderate to heavy growth. In addition, 5 of the 10 tissue samples of affected jejunum were submitted for anaerobic bacterial culture, and all 5 yielded C perfringens.

Fecal samples from 15 cows were submitted for aerobic bacterial culture for salmonellae, fecal samples from 6 cows were submitted for fluorescent antibody testing for bovine viral diarrhea virus, fecal samples from 4 cows were submitted for a polymerase chain reaction assay for epizootic hemorrhagic disease virus, and fecal samples from 2 cows were submitted for a polymerase chain reaction assay for bluetongue virus. Results for all of these tests were negative, except that Salmonella spp was isolated from 1 cow from which C perfringens was isolated.

Ten of the 17 C perfringens isolates were genotyped with a multiplex polymerase chain reaction assay. For each isolate, 4 to 6 individual colonies were selected on the basis of colony characteristics consistent with C perfringens colony morphology and a double zone of hemolysis on blood agar plates. Five of the 10 isolates from cows with HBS were identified as C perfringens type A, and 5 were identified as C perfringens type A with the β2 toxin gene. Four of the 5 cows from which C perfringens type A was isolated died, whereas all 5 cows from which C perfringens type A with the β2 toxin gene was isolated died.

Discussion

Results of the present study confirm previous reports that HBS is a sporadic acute intestinal disorder of adult cattle characterized by intraluminal hemorrhage and obstruction of the small intestine. Medical treatment of HBS was largely unsuccessful in these cows, with 7 of 8 cows treated medically dying. Surgical treatment was slightly more successful, but 9 of 13 cows that underwent surgery died or were euthanatized. However, 4 of 9 cows in which the obstruction could be removed at the time of surgery or in which the affected segments of intestine could be resected survived. Although a definitive cause was not identified in these cows, C perfringens was isolated from feces from 17 of 20 cows.

Although various names have been coined for this syndrome, the term HBS was chosen for the present study as being the most descriptive. Other names that have been used suggest that the disease is invariably fatal (eg, fatal jejunal hemorrhage syndrome), which was not the case for cows in the present study, that the disease is localized to jejunum (eg, jejunal hemorrhage syndrome), or that intraluminal bleeding is the predominant disease process (eg, intraluminal-intramural hemorrhage of the intestine). In our opinion, reference to this condition as a syndrome better implies the lack of knowledge regarding etiology.

Hematologic and serum biochemical abnormalities among cows in the present study were largely reflective of the acute nature of HBS and the resultant gastrointestinal stasis. Neutrophilia with an accompanying increase in segmented neutrophil count may be attributable to release of inflammatory cytokines, leading to subsequent release of neutrophils from the bone marrow. Alternatively, high neutrophil counts may be attributable, at least in part, to endogenous steroid release associated with the stress of disease. Similarly, hyperglycemia may be attributable to the stress of disease, with resultant endogenous steroid and epinephrine release. Functional or physical obstruction of the proximal portion of the small intestine in these cows likely resulted in sequestration of abomasal secretions, with resultant hypochloremia and hypokalemia. Increases in enzyme activities, particularly activities of sorbitol dehydrogenase, aspartate aminotransferase, and γ-glutamyltransferase, were most likely a result of acute liver damage associated with gastrointestinal obstruction or stasis and absorption of bacteria and toxins from areas of intestinal damage. The increase in creatine kinase activity was likely indicative of muscu-
loskeletal damage associated with systemic disease and myodegeneration associated with recumbency.\(^4\)

Risk factors for HBS have not been identified, and the present study was not specifically designed to identify risk factors. However, 14 of the 22 (64%) cows in the present study developed HBS during the first 3 months after parturition. Stress associated with high-intensity milk production, increased energy in the ration, and decreased fiber in the diet have been proposed as risk factors for development of this syndrome.\(^2,3\)

Although a definitive cause of HBS in cattle has not been identified, several reports\(^1,3,5-12\) have indicated an association between \textit{C. perfringens} type A and HBS. In the present study, \textit{C. perfringens} was isolated from 17 of 20 fecal samples and from 5 of 5 intestinal biopsy specimens. However, the organism is presumed to be a part of the normal flora of the intestine of livestock\(^6,8\) and proliferates quickly after death, making results of bacterial culture of fecal samples of questionable diagnostic importance.\(^1,6,9-11,a\) In addition, \textit{C. perfringens} is ubiquitous in the environment and is a commensal organ-

This, it is unclear whether proliferation of \textit{C. perfringens} is part of the primary disease process in cows with HBS or occurs as a secondary response. However, \textit{C. perfringens} type A has been isolated from intraluminal blood clots obtained from the jejunum at the time of surgery or necropsy in cattle with HBS.\(^1,6,9-11,a\) In addition, \textit{C. perfringens} is ubiquituous in the environment and is a commensal organ-

Thus, we believe that \textit{C. perfringens} may be important in the pathogenesis of this syndrome.

Although clinical and histologic findings for cows in the present study with HBS were similar to findings reported for other species with clostridial enteritis,\(^2,3\) intraluminal bleeding with subsequent development of large adherent clots was a consistent finding in these cows. Such intraluminal bleeding is not typically associated with clostridial enteritis in other species, and the cause of clot formation in cows with HBS remains unclear at this time.

A multiplex polymerase chain reaction assay\(^14,15\) was used to genotype \textit{C. perfringens} isolates from 10 cows in the present study. Five of the isolates were \textit{C. perfringens} type A, and the other 5 were \textit{C. perfringens} type A with the $\beta_2$ toxin gene. Currently, however, no vaccine approved for use in cattle in the United States contains \textit{C. perfringens} type A or \textit{C. perfringens} type A with the $\beta_2$ toxin gene. Bacterin-toxoids for types C and D are currently available but do not appear to protect cattle from HBS.\(^1,6\) The dairy from which all cows in the present study came routinely vaccinated all animals 2 or 3 times a year with a \textit{C. perfringens} types C and D toxoid.


References


